Solutions

Each answer shows the steps, then the **result**.

2.1

- chlorine, Cl_2; with an $AlCl_3$ (aluminium chloride) catalyst

2.2

- nucleophilic substitution

2.3

- Chlorine with an aluminium chloride catalyst; anhydrous conditions at room temperature

2.4

- A lone pair on the chlorine overlaps with the delocalised π system of the ring, giving the bond partial double-bond character so it is shorter and stronger

2.5

- No precipitate is formed

3.1 B

- A Cl lone pair overlaps the delocalised ring, giving partial double-bond character and a stronger C–Cl bond

3.2 B

- Chloroethane (a halogenoalkane) reacts fastest; the aryl C–Cl bonds resist substitution

3.3

- a lone pair on chlorine overlaps the delocalised ring, giving the C–Cl bond partial double-bond character so it is shorter and stronger / harder to break; and the electron-rich ring repels the approaching nucleophile

3.4

- 2-chloromethylbenzene and 4-chloromethylbenzene; the $-CH_3$ group directs the chlorine to positions 2 and 4

3.5

(a)

- 1-chlorobutane gives a white precipitate of silver chloride; chlorobenzene gives no precipitate

(b)

- In chlorobenzene a lone pair on the chlorine overlaps with the ring's delocalised π system; the C–Cl bond therefore has partial double-bond character and is shorter and stronger; it is not broken under these conditions, so no chloride ion is released

(c)

- The delocalised π electrons lie above and below the ring, giving a region of high electron density which repels the approaching hydroxide ion

(d)

- $CH_3CH_2CH_2CH_2Cl + OH^- \rightarrow CH_3CH_2CH_2CH_2OH + Cl^-$; nucleophilic substitution

(e)

- Deactivating means the ring reacts more slowly than benzene, because chlorine withdraws electron density inductively; 2,4-directing means that when substitution does occur, the new group enters mainly at the positions next to and opposite the chlorine